A Statistical Study of Proton Source Down Time

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Purpose

- This study examines the frequency of substantial downtimes and repair time
- This study <u>does not</u> examine operational issues such as:
 - Beam quality
 - Nuisance trips
- The data for this study comes from the past 30 years (1980-2010) of Downtime Logger entries
 - Analyzed over 45,000 entries

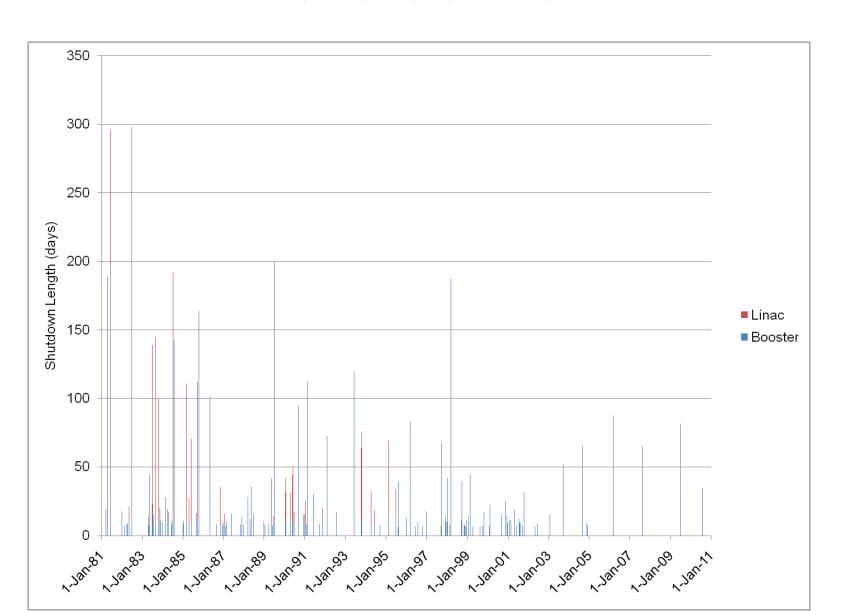
Definition

- Nuisance trip
 - a downtime of a duration less than 2 minutes
- Shutdown
 - the absence of any downtime logger entries for a period greater than 6.5 days
- Overlapping Entries
 - Two downtime entries in which the start time of one entry is in between the start and end time of the other entry
- Time to Failure
 - interval between successive downtime logger entries
- Time to Repair
 - the length of a downtime
- Cumulative Time to Failure -
 - The time that is greater than a specified percentage of failure times
 - i.e. an 80% cumulative Time to Failure of 10 hours means that 80% the entries had a time between failures
 of less than 10 hours
- Cumulative length to repair
 - The time that is greater than a specified percentage of repair times
- Interval
 - span of time over which data is analyzed
- Interval step
 - The amount of time between the start of two successive intervals.

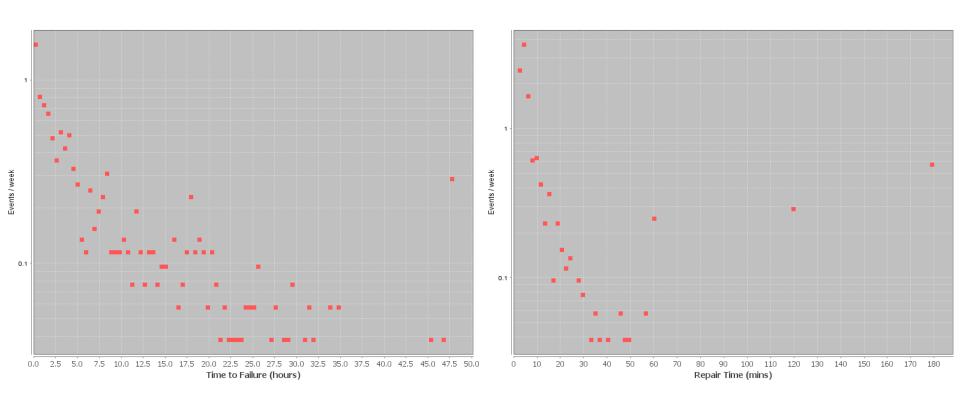
Data Scrubbing

- Booster and Linac analyzed separately
- Entries with missing downtime lengths removed (very small percentage of entries)
- Shutdowns indentified and inserted
- Nuisance trips removed
- Number of systems identified and analyzed
- Overlapping entries coalesced for global analysis

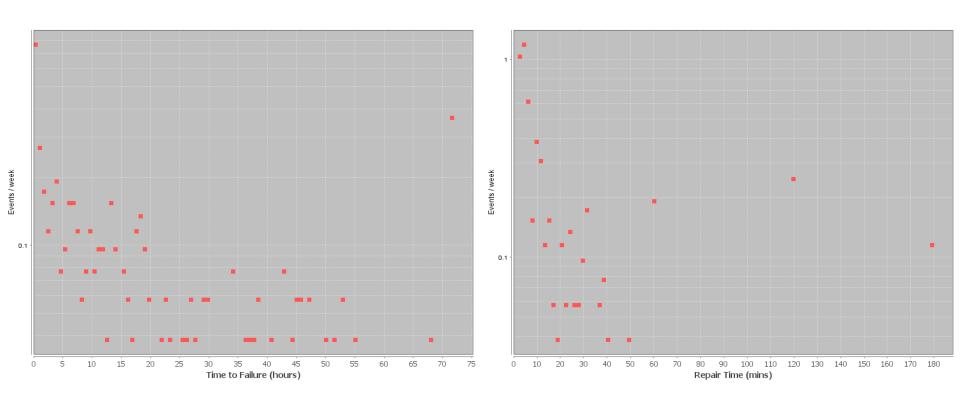
Shutdowns



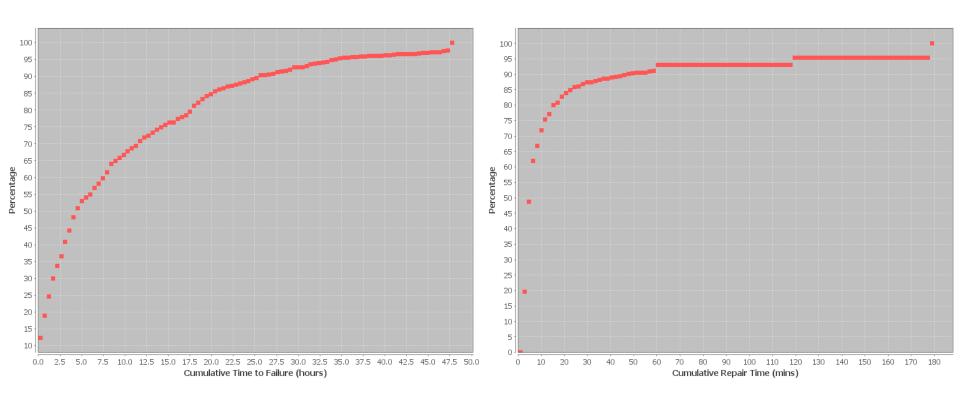
Linac Global Time To Failure and Repair Time 01-Jan-2099 – 01-Jan-2010



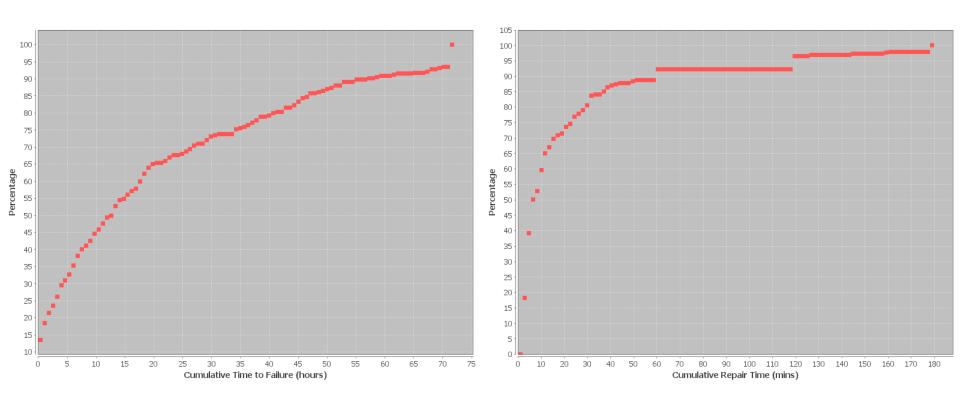
Booster Global Time To Failure and Repair Time 01-Jan-2099 – 01-Jan-2010



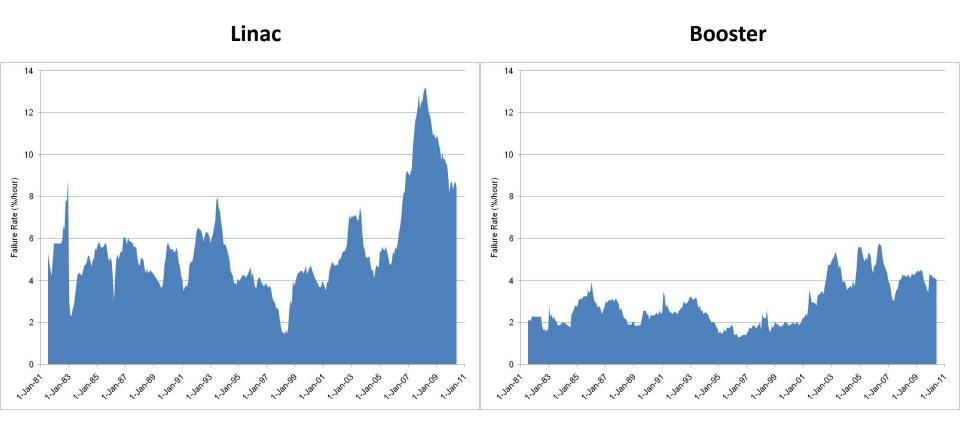
Linac Global Cumulative Time To Failure and Repair time 01-Jan-2099 – 01-Jan-2010



Booster Global Cumulative Time To Failure and Repair time 01-Jan-2099 – 01-Jan-2010

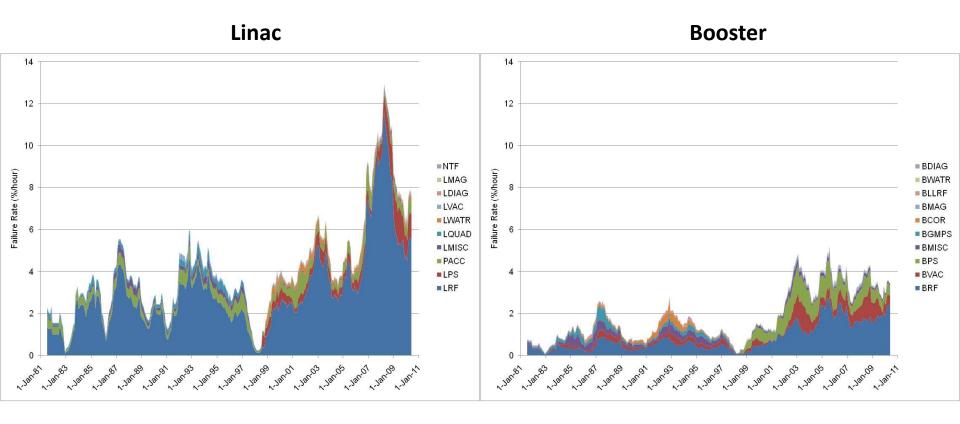


Yearly Global Mean Failure Rate



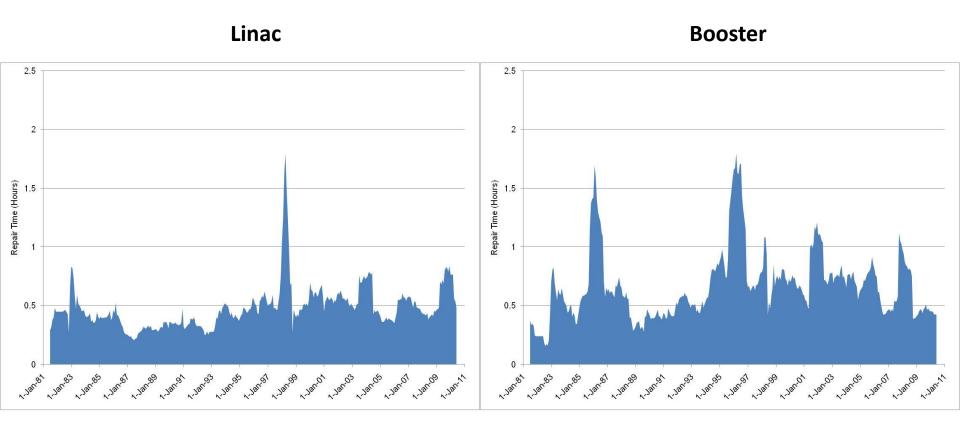
- Mean Failure Rate = 1 / Mean Time Between Failures
 - A Mean Failure Rate of 10%/per hour indicates that the likelihood of a failure in the next hour is 10%

Yearly System Mean Failure Rate

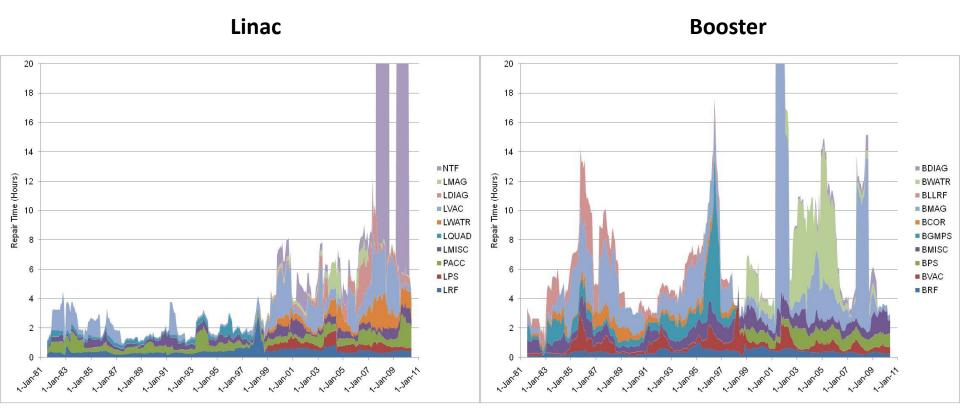


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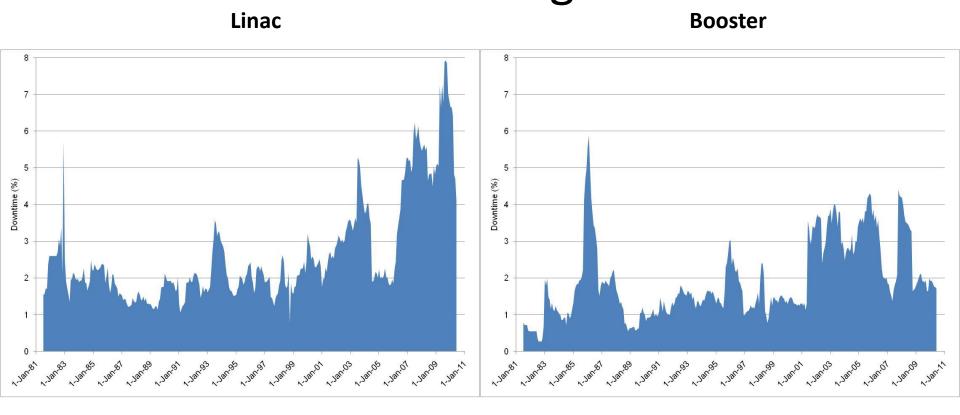
Yearly Global Mean Repair Time



Yearly System Mean Repair Time

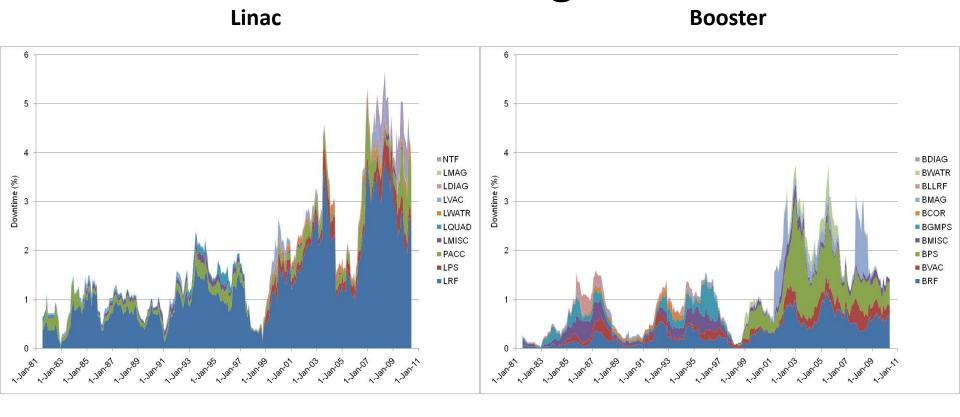


Yearly Global Mean Downtime Percentage



Mean Downtime Percentage = Mean Failure
 Rate x Mean Repair Time

Yearly System Mean Downtime Percentage



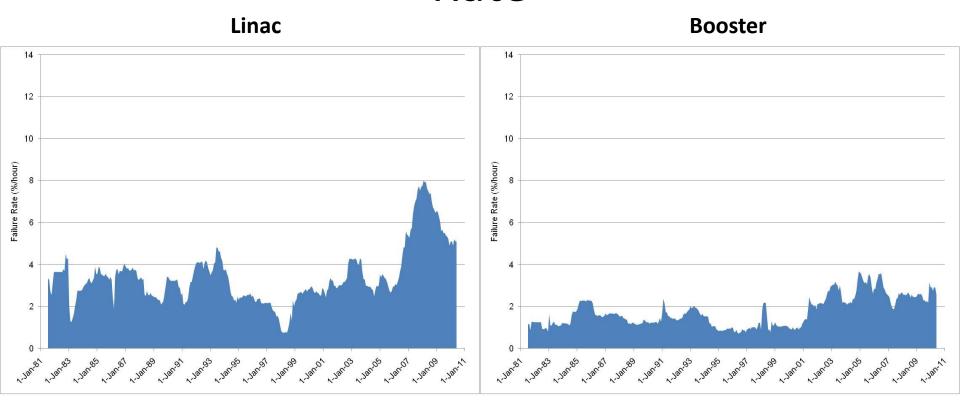
Mean Downtime Percentage = Mean Failure
 Rate x Mean Repair Time

Conclusions

- If your run the machines, they will break
- If you spend a lot of time on computers, there
 is no end to the amount of colorful pictures
 you can make

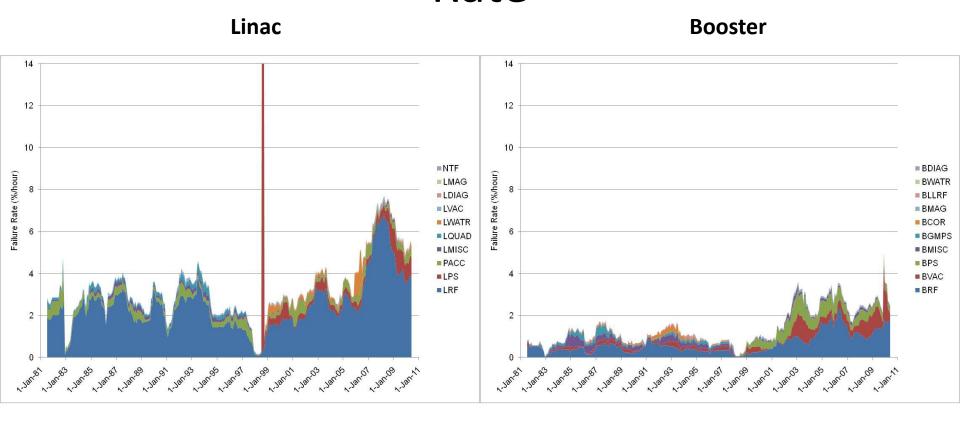
LESS USEFUL SLIDES

Yearly Global 80% Cumulative Failure Rate



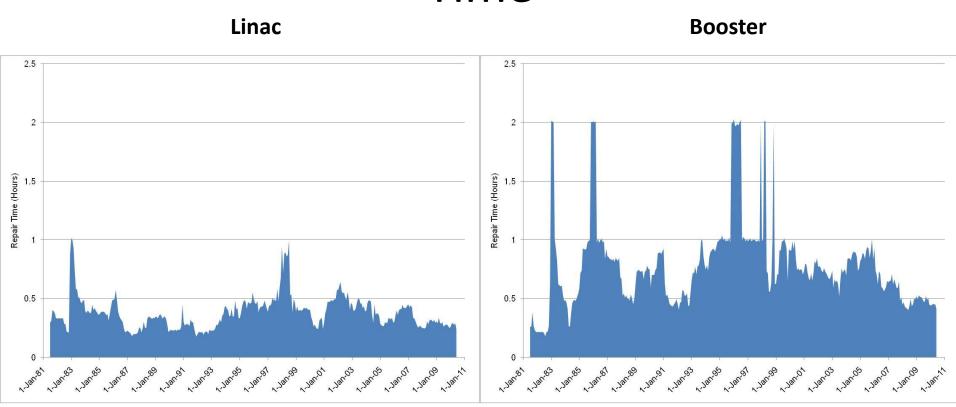
80% Cumulative Failure Rate = 1 / 80%
 Cumulative Time to Failure

Yearly System 80% Cumulative Failure Rate

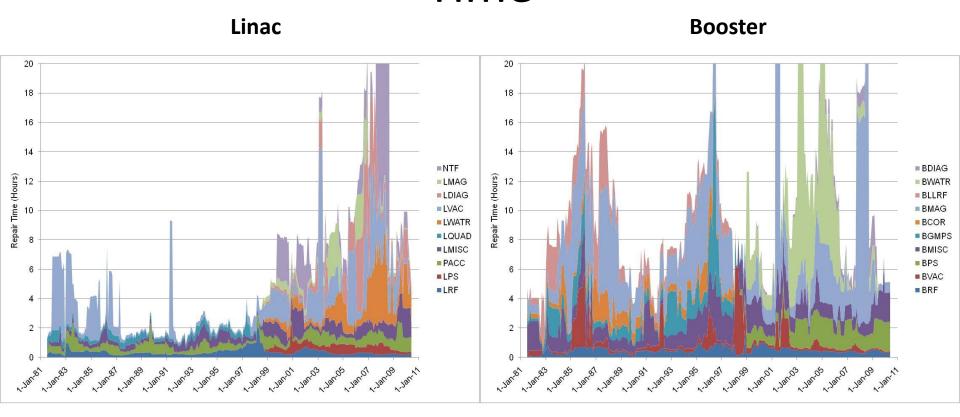


80% Cumulative Failure Rate = 1 / 80%
 Cumulative Time to Failure

Yearly Global 80% Cumulative Repair Time

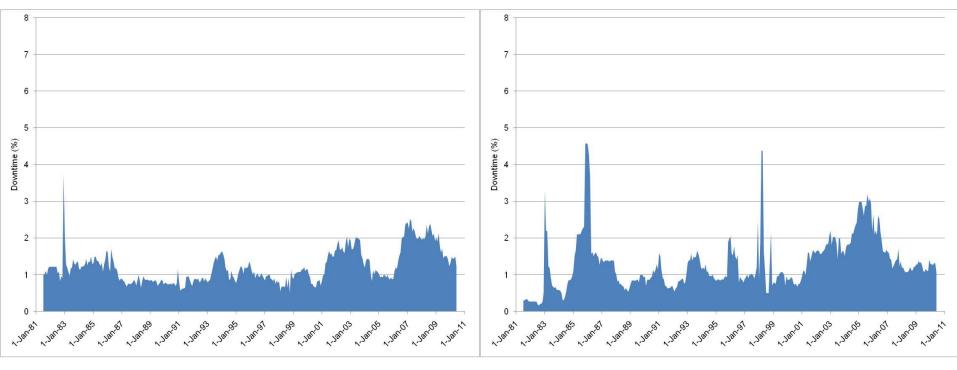


Yearly System 80% Cumulative Repair Time



Yearly Global 80% Cumulative Downtime Percentage

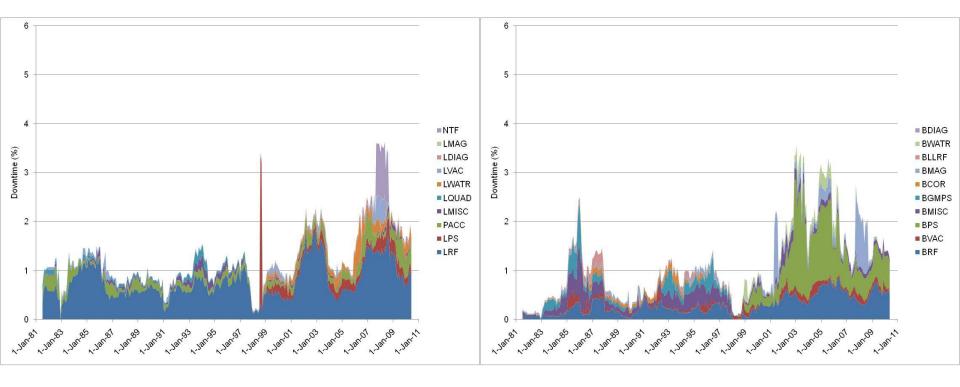
Linac Booster



80% Cumulative Downtime Percentage = 80%
 Cumulative Failure Rate x 80% Cumulative Repair Time

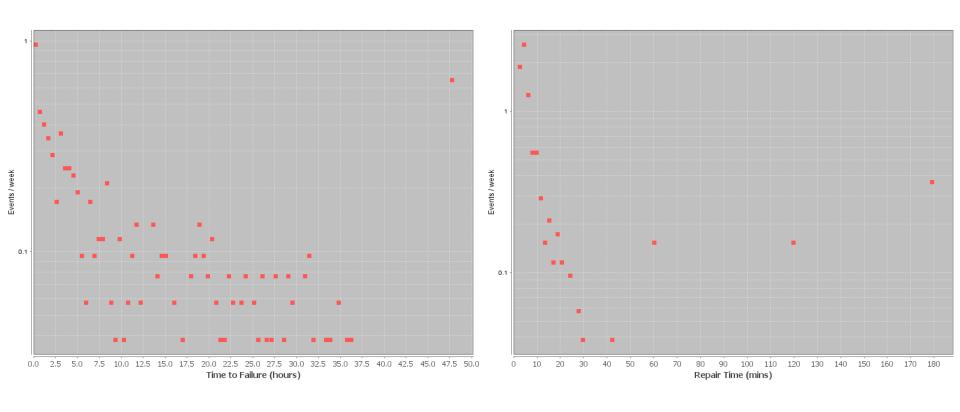
Yearly System 80% Cumulative Downtime Percentage

Linac Booster

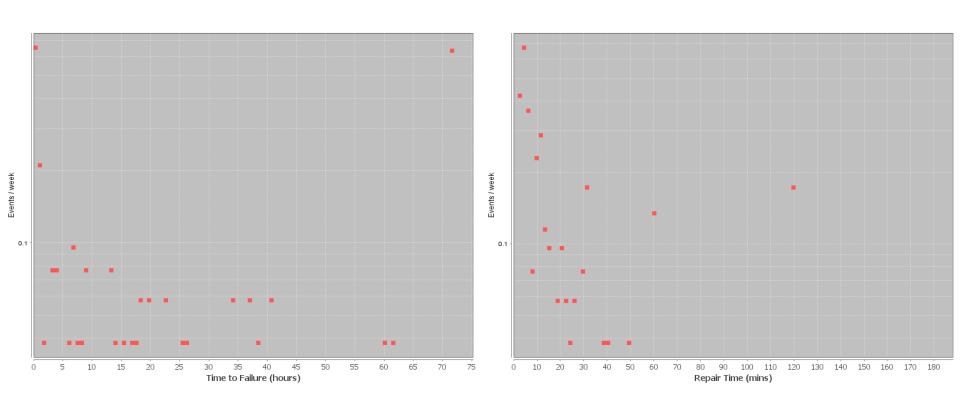


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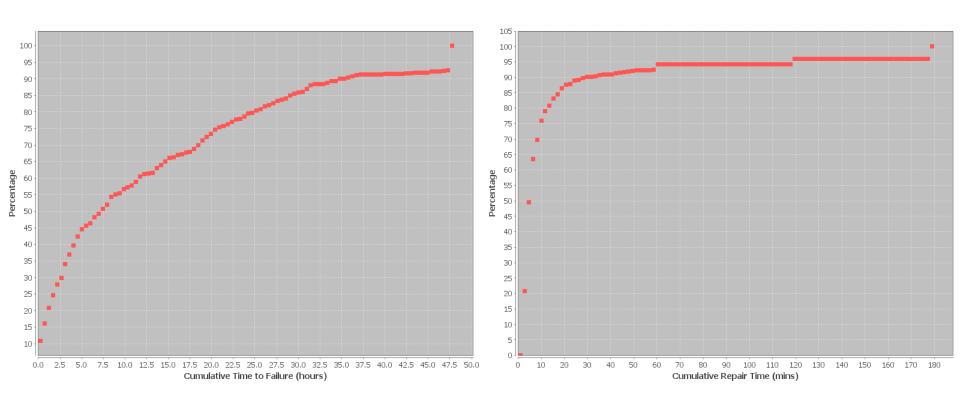
Linac LRF Time To Failure and Repair Time 01-Jan-2099 – 01-Jan-2010



Booster BRF Time To Failure and Repair Time 01-Jan-2099 – 01-Jan-2010



Linac LRF Cumulative Time To Failure and Repair time 01-Jan-2099 – 01-Jan-2010



Booster BRF Cumulative Time To Failure and Repair time 01-Jan-2099 – 01-Jan-2010

